

WHAT IS CLAIMED IS:

1. A method for recognizing at least two types of optical discs, which are associated with multiple different numerical apertures, the method comprising the steps of:

setting the numerical aperture of focusing means equal to a first one of the multiple different numerical apertures, the focusing means being used to focus a light beam on a data storage layer of a given optical disc, the first numerical aperture being smaller than any of the other numerical apertures; and

recognizing the type of the given optical disc by the first numerical aperture that has been selected in the step of setting the numerical aperture.

2. An apparatus for recognizing the type of a given optical disc by controlling an optical disc drive, which accesses at least two types of optical discs associated with multiple different numerical apertures, the apparatus comprising:

setting changing means for setting the numerical aperture of focusing means equal to a first one of the multiple different numerical apertures, the focusing means being used to focus a light beam on a data storage layer of the given optical disc, the first numerical aperture being

smaller than any of the other numerical apertures; and

recognizing means for recognizing the type of the given optical disc, loaded in the optical disc drive, by the first numerical aperture that has been selected by the setting changing means.

3. An optical disc drive for accessing at least two types of optical discs, which are associated with multiple different numerical apertures, the optical disc drive comprising:

focusing means for focusing a light beam on a data storage layer of a given optical disc at a changeable numerical aperture;

detecting means for detecting light that has been reflected from the given optical disc, on which the light beam was focused by the focusing means;

setting means for setting the numerical aperture of the focusing means equal to a first one of the multiple different numerical apertures, the first numerical aperture being smaller than any of the other numerical apertures; and

recognizing means for recognizing the type of the given optical disc by a signal representing a reflected and detected portion of the light from the optical disc on which the light beam was focused at the first numerical aperture that had been selected by the setting means.

4. The optical disc drive of claim 3, wherein the setting means selects one of the multiple different numerical apertures after another in an ascending order by beginning with the smallest, first numerical aperture, and

wherein the recognizing means determines, by the signal representing the reflected and detected portion of the light from the optical disc on which the light beam was focused at the numerical aperture that had been selected by the setting means, whether the given optical disc is a type associated with the numerical aperture currently selected.

5. The optical disc drive of claim 3, further comprising:

light source means for selectively emitting one of a plurality of light beams with multiple different wavelengths corresponding to the multiple different numerical apertures; and

wavelength selecting means for setting the wavelength of the light beam emitted from the light source means equal to a first one of the multiple different wavelengths when the setting means sets the numerical aperture of the focusing means equal to the first numerical aperture, the first wavelength being longer than any of the other wavelengths,

wherein the focusing means focuses the light beam that

has been emitted from the light source means.

6. The optical disc drive of claim 3, further comprising light source means for selectively emitting one of a plurality of light beams with multiple different wavelengths corresponding to the multiple different numerical apertures,

wherein the focusing means focuses the light beam that has been emitted from the light source means, and

wherein the numerical aperture of the focusing means changes with the wavelength of the light beam to be focused, and

wherein the setting means sets the wavelength of the light beam emitted from the light source means equal to a first one of the multiple different wavelengths, thereby setting the numerical aperture of the focusing means equal to the first numerical aperture, the first wavelength being longer than any of the other wavelengths.

7. The optical disc drive of claim 5 or 6, wherein the setting means selects one of the multiple different numerical apertures after another in an ascending order by beginning with the smallest, first numerical aperture, and

wherein the setting means or the wavelength selecting means selects one of the multiple different wavelengths after another in a descending order by beginning with the longest, first wavelength, and

wherein the recognizing means determines, by the signal representing the reflected and detected portion of the light from the optical disc on which the light beam was focused at the selected numerical aperture and wavelength, whether the given optical disc is a type associated with the numerical aperture and wavelength currently selected.

8. The optical disc drive of claim 5 or 6, wherein the at least two types of optical discs include light beam passage layers with multiple different thicknesses to pass the light beam, and

wherein the optical disc drive further comprises:

spherical aberration correcting means for correcting a spherical aberration produced on the spot of the light beam that has been focused on the data storage layer of the given optical disc; and

spherical aberration regulating means for setting the magnitude of correction to be made by the spherical aberration correcting means equal to a first correction value when the setting means sets the numerical aperture of the focusing means equal to the first numerical aperture, the first correction value being associated with the largest one of the multiple different thicknesses.

9. The optical disc drive of claim 8, wherein the

setting means selects one of the multiple different numerical apertures after another in an ascending order by beginning with the smallest, first numerical aperture, and

wherein the setting means or the wavelength selecting means selects one of the multiple different wavelengths after another in a descending order by beginning with the longest, first wavelength, and

wherein the spherical aberration regulating means selects one of multiple correction values, associated with the multiple different thicknesses, after another in a descending order by beginning with the largest, first correction value, and

wherein the recognizing means determines, by the signal representing the reflected and detected portion of the light from the optical disc on which the light beam was focused at the selected numerical aperture, wavelength and correction value, whether the given optical disc is a type associated with the numerical aperture, wavelength and correction value currently selected.

10. The optical disc drive of claim 9, wherein the multiple different thicknesses include at least one of the ranges of: $1.2+0.3$ mm to $1.2-0.1$ mm; $0.6+0.53$ mm to $0.6-0.5$ mm; $100+5$ μ m to $100-5$ μ m; and $75+5$ μ m to $75-5$ μ m.

11. The optical disc drive of one of claims 5 to 10, wherein the multiple different wavelengths include at least one of the ranges of: 400 nm to 410 nm; 645 nm to 660 nm; and 775 nm to 795 nm.

12. The optical disc drive of claim 3, wherein the multiple different numerical apertures include at least one of the ranges of: $0.85 + 0.01$ to $0.85 - 0.01$; $0.6 + 0.01$ to $0.6 - 0.01$; and $0.50 + 0.01$ to $0.50 - 0.01$.

13. The optical disc drive of claim 5, wherein the multiple different wavelengths include at least one of the ranges of: $405 + 5$ nm to $405 - 5$ nm; $650 + 5$ nm to $650 - 5$ nm; and $780 + 10$ nm to $780 - 10$ nm.

14. The optical disc drive of claim 3, wherein the multiple different numerical apertures include at least one of the ranges of: $0.85 + 0.01$ to $0.85 - 0.01$; $0.6 + 0.01$ to $0.6 - 0.01$; and $0.45 + 0.01$ to $0.45 - 0.01$.

15. The optical disc drive of claim 3, wherein the signal representing the detected portion of the reflected light includes at least one of a focus error signal, a tracking error signal, a signal representing the quantity of the reflected light and a read signal.

16. A method for distinguishing at least two types of data storage layers, which are associated with multiple different numerical apertures, the method comprising the steps of:

setting the numerical aperture of focusing means equal to a first one of the multiple different numerical apertures, the focusing means being used to focus a light beam on a data storage layer of a given optical disc, the first numerical aperture being smaller than any of the other numerical apertures; and

distinguishing the data storage layer by the first numerical aperture that has been selected in the step of setting the numerical aperture.

17. An apparatus for distinguishing a given data storage layer by controlling an optical disc drive, which accesses at least two types of data storage layers associated with multiple different numerical apertures, the apparatus comprising:

setting changing means for setting the numerical aperture of focusing means equal to a first one of the multiple different numerical apertures, the focusing means being used to focus a light beam on a data storage layer of the given optical disc, the first numerical aperture being

smaller than any of the other numerical apertures; and

distinguishing means for distinguishing the data storage layer of the given optical disc, loaded in the optical disc drive, by the first numerical aperture that has been selected by the setting changing means.

18. An optical disc drive for accessing at least two types of data storage layers, which are associated with multiple different numerical apertures, the optical disc drive comprising:

focusing means for focusing a light beam on a data storage layer of a given optical disc at a changeable numerical aperture;

detecting means for detecting light that has been reflected from the given data storage layer, on which the light beam was focused by the focusing means;

setting means for setting the numerical aperture of the focusing means equal to a first one of the multiple different numerical apertures, the first numerical aperture being smaller than any of the other numerical apertures; and

distinguishing means for distinguishing the data storage layer of the given optical disc by a signal representing a reflected and detected portion of the light from the optical disc on which the light beam was focused at the first numerical aperture that had been selected by the setting

means.

19. The optical disc drive of claim 18, further comprising counting means for counting the number of the data storage layers of the given optical disc.

20. The optical disc drive of claim 18 or 19, wherein the at least two types of data storage layers are located at mutually different depths as measured from a principal surface of the given optical disc, and

wherein the optical disc drive further comprises:

vertical position changing means for moving the focusing means perpendicularly to the data storage layers; and

shifting means for getting the light beam focused on the deepest one of the data storage layers first, the second deepest one next, and so forth toward the surface of the given optical disc, by driving the vertical position changing means while the distinguishing means is distinguishing the given data storage layer.

21. The optical disc drive of claim 20, further comprising:

focusing state detecting means for generating a signal representing a focusing state of the light beam on the given data storage layer; and

focus control means for getting the light beam focused on a desired one of the data storage layers by driving the vertical position changing means in response to the signal generated by the focusing state detecting means,

wherein in accordance with a result obtained by the distinguishing means, the focus control means gets the light beam focused on the desired data storage layer earlier than any of the other data storage layers.

22. The optical disc drive of claim 21, further comprising:

spherical aberration correcting means for correcting a spherical aberration differently according to the given data storage layer; and

spherical aberration regulating means for adjusting the magnitude of correction to be made by the spherical aberration correcting means according to the desired data storage layer when the focus control means gets the light beam focused on the desired data storage layer.

23. The optical disc drive of claim 20, further comprising:

focusing state detecting means for generating a signal representing a focusing state of the light beam on the given data storage layer of the optical disc;

focus control means for getting the light beam focused on a desired one of the data storage layers by driving the vertical position changing means in response to the signal generated by the focusing state detecting means; and

storage means for bringing the focusing means closer to, or away from, the optical disc with the numerical apertures of the focusing means switched sequentially and for storing the signal of the focusing state detecting means to be output as the focusing states are changed,

wherein in accordance with the output signal of the focusing state detecting means as stored in the storage means, the focus control means corrects the amplitude and/or balance of the output signal of the focusing state detecting means in getting the light beam focused.

24. The optical disc drive of claim 20, further comprising:

focusing state detecting means for generating a signal representing a focusing state of the light beam on the given data storage layer of the optical disc;

focus control means for getting the light beam focused on a desired one of the data storage layers by driving the vertical position changing means in response to the signal generated by the focusing state detecting means;

storage means for bringing the focusing means closer to,

or away from, the optical disc with the numerical apertures of the focusing means switched sequentially and for storing the signal of the focusing state detecting means to be output as the focusing states are changed; and

interlayer jump means for shifting the focal point of the light beam from any of the data storage layers of the optical disc to another in accordance with the output signal of the focusing state detecting means,

wherein in accordance with the output signal of the focusing state detecting means as stored in the storage means, the interlayer jump means corrects the amplitude and/or balance of the output signal of the focusing state detecting means in shifting the focal point from one layer to another.